AVAILABILITY AND ESTIMATION OF RENEWABLE ENERGY FOR HABITANTS LIVING IN REMOTE PLACES

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STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

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ABSTRACT

Today, the world has been relying on fossil fuels as its primary source of energy. This unsustainable energy source is not going to last long. Thus, the green renewable energy should be practice from now on. Malaysia is gifted with many natural renewable energy resources. It is because it has a long coast line, good rainfall with rivers flowing for greater part of the year. In Malaysia also there are 82% of the remote places in Malaysia have electricity in their place but sometime this electricity is not functional because of the some problem. And for the other 12%, there are not facilities for them. The electricity is very important for our daily life for the cooking, lighting and the others activity. This thesis is presented the research to determine the suitable renewable energy use in remote places which in Malaysia. After some research, there are potential of renewable energy that can be used that is biomass energy, solar energy and wind energy. Based on the parameter in the remote place, the case study has been done for design the system for that habitant to generate the electricity. With the animal dung and excrement, biogas digester can be use. The biogas produce can generated the electricity for that place. But, the number of the animal available is less than number of animal needed for generates the whole place. After that, solar photovoltaic is the one way of the solution for this problem. Solar photovoltaic system can be use with the biogas digester. In other hand, wind turbine also can be one of the alternative ways beside the solar photovoltaic. So, this paper is discussed about the best solution for the remote place to choose the suitable renewable energy either biogas-solar photovoltaic or biogas-wind turbine.

ABSTRAK

Pada masa ini, penduduk dunia terlalu bergantung kepada bahan bakar fosil sebagai sumber tenaga utama. Sumber tenaga dari bahan bakar ini tidak akan bertahan untuk selama-lamanya kerana sumber tenaga ini tidak berkekalan. Oleh sebab itu, kita harus mula untuk menerokai sumber tenaga baru. Seperti yang kita ketahui, Malaysia telah dianugerahkan dengan pelbagai sumber tenaga baru. Ini kerana kedudukan Malaysia yang strategik, menerima jumlah hujan tahunan yang baik dengan sungai yang mengalir sepanjang tahun. Di Malaysia juga, sebanyak 82% kawasan pedalaman telah menerima sambungan elektik dari kerajaan. Walaubagaimanapun, sistem ini tidak dapat berfungsi kerana berlaku beberapa masalah yang tidak dapat dielakkan. Untuk 12% penduduk di kawasan pedalaman yang lain tidak mendapat kemudahan untuk mereka. Sistem elektrik adalah sangat penting dalam kehidupan pada masa sekarang. Dengan elektrik, penduduk dapat melakukan aktiviti masing-masing seperti memasak dan sebagainya. Tesis ini adalah mengenai kajian untuk menentukan penggunaan sumber tenaga baru yang paling sesuai untuk digunakan di kawasan pedalaman di Malaysia. Melalui beberapa kajian, potensi sumber tenaga baru yang dapat digunakan di Malaysia ialah tenaga biojisim, tenaga suria dan tenaga angin. Berdasarkan parameter daripada kawasan pedalaman, satu kajian kes telah dijalankan untuk merekabentuk satu sistem yang paling sesuai untuk menghasilkan tenaga di kawasan pedalaman. Melalui bahan buangan daripada haiwan ternakan di kawasan pedalaman, satu “biogas digester” telah dihasilkan. Melalui biogas yang keluar akan digunakan untuk menghasilkan tenaga elektrik. Namun, jumlah haiwan ternakan di kawasan itu tidak cukup untuk memberi tenaga kepada semua penduduk. Oleh itu, “solar photovoltaic” adalah salah satu sumber tenaga yang boleh digunakan bersama biogas. Selain daripada “solar photovoltaic”, tenaga daripada angin juga boleh digunakan. Oleh itu, kertas ini akan membincangkan tentang jalan yang terbaik untuk menghasilkan elektrik di kawasan pedalaman.

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P	Power
V	Voltage
I	Current
∏	Combustion efficiency
H_b	Heat of combustion of biogas
H_m	Heat of combustion of methane
F_m	Fraction of methane in biogas
V_{b-}	Volume of biogass, m^3
C	Biogas yield per unit dry mass
m_o	Mass of dry input
V_f	Volume flow rate of fluid per day, m^3/day
P_m	Density of dry matter in the fluid
T_r	Retention time in the digester, days
E	Efficiency of rotor
ρ	Density of air
r	Radius of rotor
v	Velocity of wind

LIST OF ABBREVIATIONS

GDP	Gross Domestic Product
USD	United State Dollar
SREP	Small Renewable Energy Power Program
PTM	Pusat Tenaga Malaysia
MTBE	Methyl Tertiary Butyl Ether
ETBE	Ethyl Tertiary Butyl Ether
UKM	University Kebangsaan Malaysia
PV	Photovoltaic
UiTM	Universiti Teknologi MARA
FIT	Feed-in Tariff

CHAPTER 1

INTRODUCTION

1.0 PROJECT BACKGROUND

The Malaysian population of about 28.5 million is spread over an area of 329,759 sq.km comprises of thirteen states and has an average population density of 86 per square kilometer. About 18% of the populations live in remote places and does not have electrical connection from the main grid. About 75% of the land is covered with rainforests with population density spread as shown in Figure 1 makes it highly uneconomical to lay transmission lines in certain locations. The occupation of the people living in these remote places are mostly farming, fishing and others activity. These animals and trees provided most of their energy requirements.

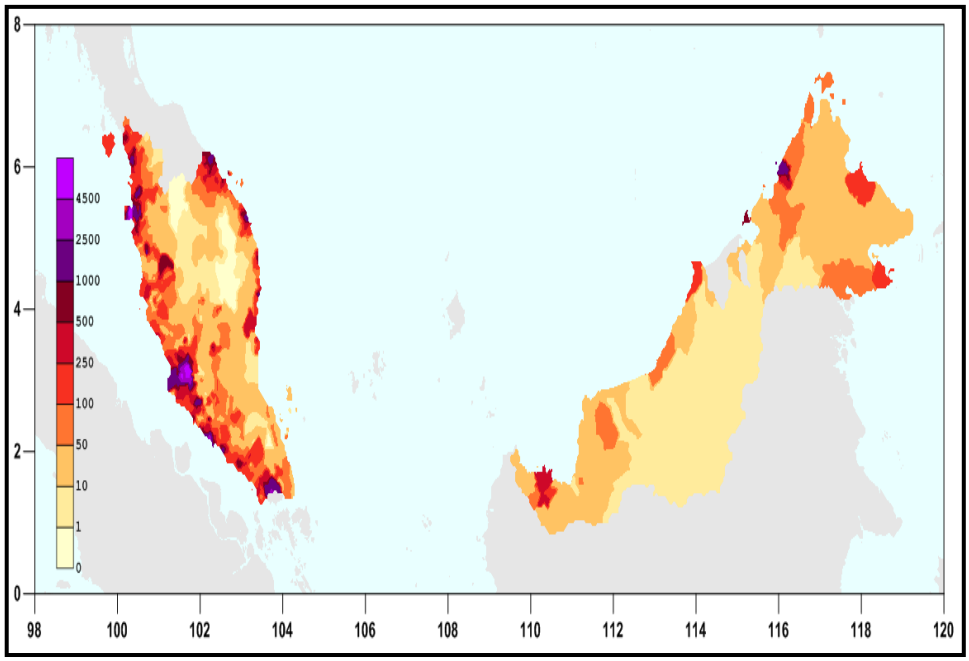

Figure 1.1: Average population density for Malaysia

Malaysia is gifted with many natural renewable energy resources as shown in Figure 1.1. It has a long coast line, good rainfall with rivers flowing for greater part of the year. As it is located near the equator it has high solar insolation prevailing for most part of the year. However, the renewable resources are not utilized to a large extent due to the availability of crude petroleum and palm oil in sufficient quantities.

Malaysia ranks 56 in the world with a GDP of USD13, 315 per capita and plans to upgrade as a developed nation by the year 2020. In line with these objectives and rising concerns of global warming it is important to promote the use of renewable energy to enhance the living standards of its people, especially in remote places.

2.0 WORLD RENEWABLE ENERGY RESOURCES.

The world energy demands are basically met by fossil fuels such as oil, coal and natural gas. The foreseeable depletion of these fossil fuel reserves within the next 40–50 year and the expected environmental damages due the global warming have catalyzed the world to shift towards the use of renewable energy resources. There is a need to explore these renewable energy sources like solar, wind, hydro, biomass, etc for sustainable growth. Table 1.1 is shown the current used as technical and theoretical potentials for renewable energy. These resources have an advantage that makes it uniquely suited to certain applications. Also the resources do not release gaseous or liquid pollutants during their operation. The use of renewable energy will steer the energy policy of nations in the direction of sustainability and lead to better energy security.

Table 1.1: Current use (2004) as well as technical and theoretical potentials for various renewable energy sources (in term of primary energy) at global scale

Global theoretical and technical potentials (Unit: EJ)			
Resource	Current use (2004)	Technical potential	Theoretical potential
Solar energy	0.2	1600	3,900,000
Wind energy	0.2	600	6000
Hydropower	10	50	150
Ocean energy	-	-	7400
Geothermal energy	2	5000	140,000,000
Biomass energy	50	250	2900
Total	62.4	7500	143,916,450

Source: IEA (2007b), Johansson et al. (2004) and Rogner et al. (2004)

2.1 SOLAR POWER

The sun has produced energy for billions of years. Solar energy is the sun's rays (solar radiation) that reach the Earth. This energy can be converted into other forms of energy, such as heat and electricity. Usually the people used the Sun for drying clothes and food for thousands of years, but only recently have use it for generating power. The Sun is 150 million kilometers away, and amazingly powerful. Just the tiny fraction of the Sun's energy that hits the Earth (around a hundredth of a millionth of a percent) is enough to meet all our power needs many times over. In fact, every minute, enough energy arrives at the Earth to meet our demands for a whole year - if only it harness it properly. Solar power is the generation of electricity from sunlight. Solar energy is radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies.

Solar energy can be used for heat and electricity. When solar was converted to thermal energy, it can be used to heat water and heat spaces. Usually, heat water heater is for use in home, building or swimming pools and heat spaces is usually used inside homes, greenhouses and other buildings. For electricity, solar energy can be converting in two ways. First is photovoltaic (PV) or in other name is solar cell. This process can change sunlight directly into electricity. Individual PV cells are grouped into panels and arrays of panels that can be used in a wide range of applications ranging from single small cells that charge calculator and watch batteries, to systems that power single homes, to large power plants covering many acres. The other way is concentrating solar power plant to generate electricity by using the heat from solar thermal collectors to produce steam that is used to power the generator.

2.2 WIND POWER

The power from wind have been harnessing for hundreds of years. Wind energy harnesses the power of the wind to propel the blades of wind turbines. The rotation of turbine blades is converted into electrical current by means of an electrical generator. In the older windmills, wind energy was used to turn mechanical machinery to do physical

work, like crushing grain or pumping water. Wind turbines, like windmills, are mounted on a tower to capture the most energy. At 100 feet (30 meters) or more aboveground, they can take advantage of the faster and less turbulent wind. Turbines catch the wind's energy with their propeller-like blades. Usually, two or three blades are mounted on a shaft to form a rotor. A blade acts much like an airplane wing. While the wind blows, a pocket of low-pressure air forms on the downwind side of the blade. The low-pressure air pocket then pulls the blade toward it, causing the rotor to turn. This is called lift. The force of the lift is actually much stronger than the wind's force against the front side of the blade, which is called drag. The combination of lift and drag causes the rotor to spin like a propeller, and the turning shaft spins a generator to make electricity.

Now, electrical currents are harnessed by large scale wind farms that are used by national electrical grids as well as small individual turbines used for providing electricity to isolated locations or individual homes. Wind power is renewable and produces no greenhouse gases during operation, such as carbon dioxide and methane.

2.3 HYDRO POWER

Hydropower is power that is derived from the force or energy of moving water, which may be harnesses for useful purpose. Since water is about 800 times denser than air even a slow flowing stream of water, or moderate sea swell, can yield considerable amounts of energy. There are many forms of water energy like hydroelectric, ocean, rain, tidal and steam.

Hydro power is depends on the water cycle. Water cycle describes the continuous movement of water on, above and below the surface of the earth. Water can change states among liquid, vapour and ice at various places in the water cycle. From the Figure 1.2, solar energy heats water on the surface, causing it to evaporate. Then, this water vapor condenses into clouds and falls back onto the surface as precipitation like rain, snow and etc.). Lastly, the water flows through rivers back into the oceans, where it can evaporate and begin the cycle over again.

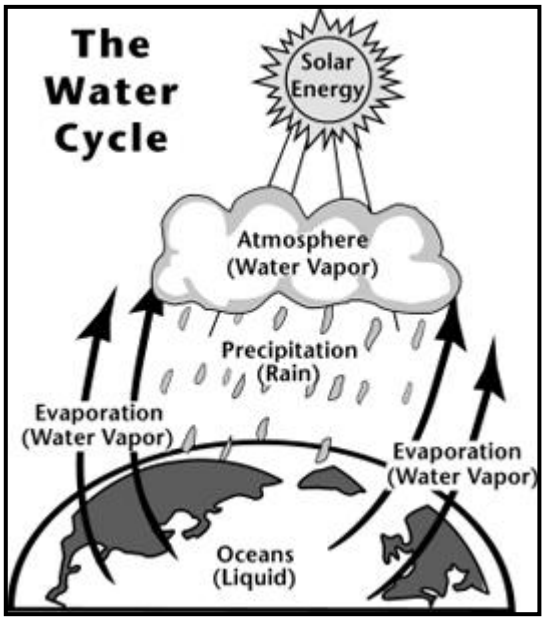

Figure 1.2: Process of water cycle

Source: National Energy Education Development Project (Public Domain)

Flowing water creates energy that can be captured and turned into electricity. This is called hydroelectric power or hydropower. Mechanical energy is harnessed from moving water. The amount of available energy in moving water is determined by its flow or fall. Swiftly flowing water in a big river, like the Rajang River that located in Sarawak, carries a great deal of energy in its flow. Water moves rapidly from a very high point. It also has lots of energy in its flow. In either instance, the water flows through a pipe, or penstock, then pushes against and turns blades in a turbine to spin a generator to produce electricity. In a run-of-the-river system, the force of the current applies the needed pressure, while in a storage system, water is accumulated in reservoirs created by dams as shown in Figure 1.3, then released as needed to generate electricity.

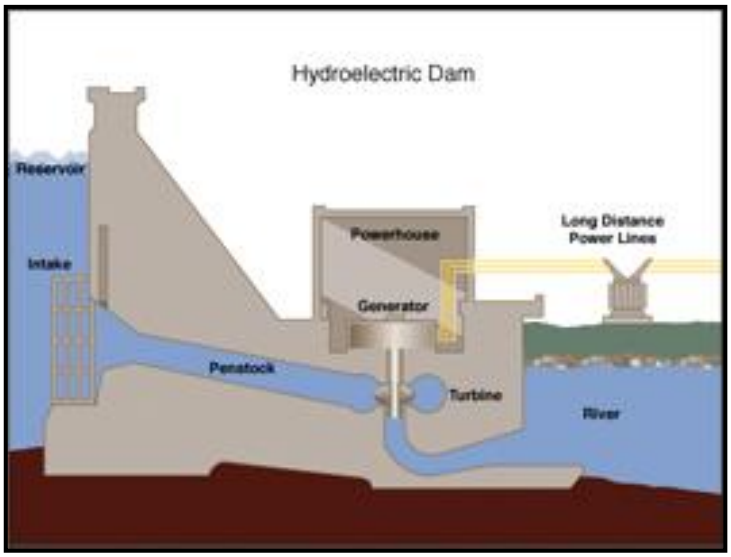

Figure 1.3: Dam system

Malaysia is a country mostly surrounded by water. In Malaysia, there are a few dams that are being used to generate the electric. For example, Kenyir dam in Terengganu. It generates 1600 GW per year. Kenyir dam is a biggest dam in Peninsular Malaysia. Others include Pergau dam in Kelantan with installed capacity of 150 MW from 4 turbines..

2.4 ENERGY FROM OCEANS

The Ocean can produce two types of energy that thermal energy from the sun's heat, and mechanical energy from the tides and waves. Oceans cover more than 70% of Earth's surface, making them the world's largest solar collectors. The sun's heat warms the surface water a lot more than the deep ocean water, and this temperature difference creates thermal energy. Just a small portion of the heat trapped in the ocean could power the world. In tropical regions, the surface water can be much warmer than the deep water as shown in Figure 1.4. This temperature difference can be used to produce electricity. Ocean thermal energy is used for many applications, including electricity generation. There are three types of electricity conversion systems namely closed-cycle, open-cycle, and hybrid. Closed-cycle systems use the ocean's warm surface water to

vaporize a working fluid, which has a low-boiling point, such as ammonia. The vapor expands and turns a turbine. The turbine then activates a generator to produce electricity. Open-cycle systems actually boil the seawater by operating at low pressures. This produces steam that passes through a turbine or generator. Hybrid systems combine both closed-cycle and open-cycle systems.

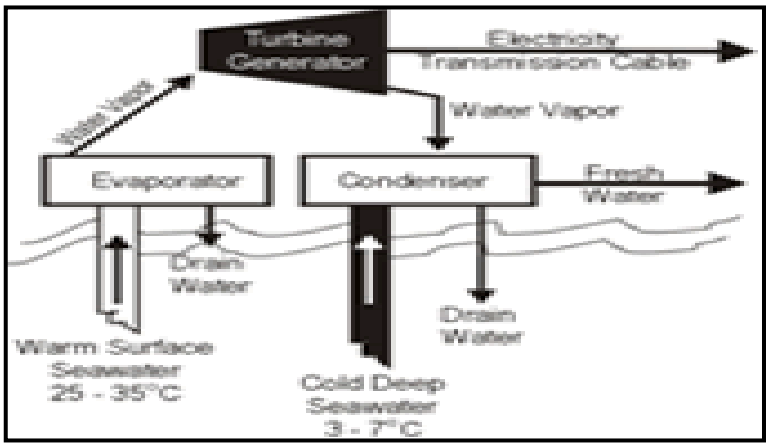

Figure 1.4: Diagram of ocean system

Tidal Power, sometimes also called tidal energy, is a form of hydropower that converts the energy of tides into electricity or other useful forms of power. Although not yet widely used, tidal power has potential for future electricity generation. Tides are more predictable than wind energy and solar power. Tides are caused by the gravitational pull of the moon and sun, and the rotation of the Earth. Near shore, water levels can vary up to 40 feet due to tides. A simple generation system for tidal plants involves a dam, known as a barrage, across an inlet. Sluice gates (gates commonly used to control water levels and flow rates) on the barrage allow the tidal basin to fill on the incoming high tides and to empty through the turbine system on the outgoing tide, also known as the ebb tide. There are two-way systems that generate electricity on both the incoming and outgoing tides. Tidal fences can also harness the energy of tides. A tidal fence has vertical axis turbines mounted in a fence. All the water that passes is forced through the turbines. Tidal fences can be used in areas such as channels between two landmasses. Tidal fences are cheaper to install than tidal barrages and have less impact

on the environment than tidal barrages, although they can disrupt the movement of large marine animals.

Wave have a lots of energy. Waves are caused by the wind blowing over the surface of the ocean. There is tremendous energy in the ocean waves. One way to harness wave energy is to bend or focus the waves into a narrow channel, increasing their power and size. The waves can then be channeled into a catch basin or used directly to spin turbines. Many more ways to capture wave energy are currently under development. Some of these devices being developed are placed underwater, anchored to the ocean floor, while others ride on top of the waves. Waves are generated by wind passing over the surface of the sea. As long as the waves propagate slower than the wind speed just above the waves, there is an energy transfer from the wind to the waves. Both air pressure differences between the upwind and the side of a wave crest, as well as friction on the water surface by the wind, making the water to go into the shear stress causes the growth of the waves.

In general, larger waves are more powerful but wave power is also determined by wave speed, wavelength, and water density. Oscillatory motion is highest at the surface and diminishes exponentially with depth. However, for standing waves near a reflecting coast, wave energy is also present as pressure oscillations at great depth, producing microseisms. These pressure fluctuations at greater depth are too small to be interesting from the point of view of wave power.

The waves propagate on the ocean surface, and the wave energy is also transported horizontally with the group velocity. The mean transport rate of the wave energy through a vertical plane of unit width, parallel to a wave crest, is called the wave energy flux or on other name wave power.

2.5 GEOTHERMAL ENERGY

Literally, geothermal means earth heat. Geothermal energy harnesses the heat energy present underneath the Earth. Geothermal energy is a renewable energy source

because the heat is continuously produced inside the Earth. Hot rocks under the ground heat water to produce steam. When holes are drilled in the region, the steam that shoots up is purified and is used to drive turbines, which power electric generators. Geothermal energy is generated in the Earth's core. Temperatures hotter than the sun's surface are continuously produced inside the Earth by the slow decay of radioactive particles, a process that happens in all rocks. People around the world use geothermal energy to heat their homes and to produce electricity by digging deep wells and pumping the heated underground water or steam to the surface. The stable temperatures near the surface of the Earth can be use to heat and cool buildings. Geothermal power plants use hydrothermal resources that have two common ingredients that is water (hydro) and heat (thermal). Geothermal plants require high temperature (300°F to 700°F) hydrothermal resources that may come from either dry steam wells or hot water wells. These resources can be use by drilling wells into the Earth and piping the steam or hot water to the surface. Geothermal wells are one to four kilometer deep. There are four types of geothermal plants. First, dry steam plants use steam piped directly from a geothermal reservoir to turn the generator turbines. The first geothermal power plant was built in 1904 in Tuscany, Italy, where natural steam erupted from the Earth. Second is flash steam plants take high-pressure hot water from deep inside the Earth and convert it to steam to drive the generator turbines. When the steam cools, it condenses to water and is injected back into the ground to be used over and over again. Most geothermal power plants are flash steam plants.

The hot dry rock: The heat recovered from subsurface rocks is used to generate electricity. The system proposed for extracting heat from the rock and converting it to electricity is comprised of two distinct subsystems at very different stages of their technological evolution. The two subsystems are the power plant (on the surface) and the HDR reservoir (deep beneath the surface), which are connected by deep wells. The wells and reservoir are thought of as a single system, often referred to as the well field system or reservoir system. The power plant system is largely identical to commercial binary hydrothermal electric plants. The technology for the reservoir system is much less mature. Lastly, binary cycle power plants transfer the heat from geothermal hot

water to another liquid. The heat causes the second liquid to turn to steam which is used to drive a generator turbine.

In Malaysia, Tawau has an electricity generation potential of up to 67 MW from geothermal resources following the discovery of a geothermal site in Apas by a study by the Mineral and Geosciences Department. The study also found a reservoir about 2,000 to 3,000m below the earth's surface with water at temperatures of 220 to 236 degrees Celsius which was more than enough heat to generate electricity.

2.6 BIOMASS ENERGY

Biomass, a renewable energy source, is biological material derived from living, or recently living organisms, such as wood, waste, and alcohol fuels. Biomass is commonly plant matter grown to generate electricity or produce heat. Biomass energy or bioenergy was used for thousands of years, ever since people started burning wood to cook food or to keep warm. Today, wood is still our largest biomass energy resource. But many other sources of biomass can now be used, including plants, residues from agriculture or forestry, and the organic component of municipal and industrial wastes. Even the fumes from landfills can be used as a biomass energy source. The use of biomass energy has the potential to greatly reduce our greenhouse gas emissions. Biomass generates about the same amount of carbon dioxide as fossil fuels, but every time a new plant grows, carbon dioxide is actually removed from the atmosphere. The net emission of carbon dioxide will be zero as long as plants continue to be replenished for biomass energy purposes. These energy crops, such as fast-growing trees and grasses, are called biomass feedstock. The use of biomass feedstock can also help increase profits for the agricultural industry. Burning biomass is not the only way to release its energy. Biomass can be converted to other useable forms of energy, such as methane gas or transportation fuels, such as ethanol and biodiesel.

Methane gas is the main ingredient of natural gas. Smelly stuff, like rotting garbage, and agricultural and human waste, release methane gas are also called "landfill gas" or "biogas." Crops like corn and sugar cane can be fermented to produce ethanol.